

CLAIMS

1. An electrochemical device comprising an electrode plate assembly, said electrode plate assembly comprising,

- (a) at least one first electrode,
- (b) at least one second electrode, and
- (c) a separator interposed between the first electrode and the second electrode,

said first electrode comprising a first current collector sheet and at least one first electrode mixture layer carried thereon,

said second electrode comprising a second current collector sheet and at least one second electrode mixture layer carried thereon,

at least one of said first current collector sheet and said second current collector sheet having a conductive area and an insulating area.

2. The electrochemical device in accordance with claim 1, wherein said electrochemical device further comprises a first terminal electrically connected to said first current collector sheet and a second terminal electrically connected to said second current collector sheet,

said electrode plate assembly has a first side face on which said first terminal is provided and a second

side face on which said second terminal is provided,

when said first current collector sheet has a conductive area and an insulating area, the conductive area of said first current collector sheet is connected to said first terminal on said first side face, and the insulating area of said first current collector sheet is positioned on said second side face, and

when said second current collector sheet has a conductive area and an insulating area, the conductive area of said second current collector sheet is connected to said second terminal on said second side face, and the insulating area of said second current collector sheet is positioned on said first side face.

3. The electrochemical device in accordance with claim 2, wherein said first side face and said second side face are positioned on opposite sides of said electrode plate assembly.

4. The electrochemical device in accordance with claim 2, wherein said first side face has a first insulating material portion for insulating said first terminal from said second electrode, and said second side face has a second insulating material portion for insulating said second terminal from said first electrode.

5. An electrochemical device comprising an electrode plate assembly in which a first electrode and a second electrode are wound with a separator interposed

therebetween,

wherein said first electrode comprises a first current collector sheet and at least one first electrode mixture layer carried thereon,

said second electrode comprises a second current collector sheet and at least one second electrode mixture layer carried thereon,

at least one of said first current collector sheet and said second current collector sheet has a conductive area and an insulating area,

when said first current collector sheet has a conductive area and an insulating area, the conductive area of said first current collector sheet is connected to a first terminal on a first bottom face of said electrode plate assembly, and the insulating area of said first current collector sheet is positioned on a second bottom face of said electrode plate assembly, and

when said second current collector sheet has a conductive area and an insulating area, the conductive area of said second current collector sheet is connected to a second terminal on the second bottom face of said electrode plate assembly, and the insulating area of said second current collector sheet is positioned on the first bottom face of said electrode plate assembly.

6. An electrochemical device comprising an electrode plate assembly in which a plurality of first

electrodes and a plurality of second electrodes are alternately layered with separators interposed therebetween,

wherein said plurality of first electrodes each comprise a first current collector sheet and at least one first electrode mixture layer carried thereon,

said plurality of second electrodes each comprise a second current collector sheet and at least one second electrode mixture layer carried thereon,

at least one of said first current collector sheet and said second current collector sheet has a conductive area and an insulating area,

when said first current collector sheet has a conductive area and an insulating area, the conductive area of said first current collector sheet is connected to a first terminal on a first side face of said electrode plate assembly, and the insulating area of said first current collector sheet is positioned on a second side face of said electrode plate assembly, and

when said second current collector sheet has a conductive area and an insulating area, the conductive area of said second current collector sheet is connected to a second terminal on the second side face of said electrode plate assembly, and the insulating area of said second current collector sheet is positioned on the first side face of said electrode plate assembly.

7. The electrochemical device in accordance with

claim 2, wherein the current collector sheet with said conductive area and said insulating area has a first edge that comprises a part of said conductive area and that does not carry said electrode mixture layer, said conductive area is connected to said first terminal or said second terminal at said first edge, and at least a part of said first edge is buried in said first terminal or said second terminal.

8. The electrochemical device in accordance with claim 2, wherein the current collector sheet with said conductive area and said insulating area has a second edge that comprises a part of said insulating area and that does not carry said electrode mixture layer, said second edge is positioned on said first side face or said second side face, and at least a part of said second edge is buried in said first terminal or said second terminal.

9. The electrochemical device in accordance with claim 2, wherein said electrode plate assembly further comprises a third side face and a fourth side face, and

an edge of said first current collector sheet, an edge of said second current collector sheet, and an edge of said separator are substantially flush with one another on each of said first side face, said second side face, said third side face, and said fourth side face.

10. The electrochemical device in accordance with claim 2, wherein an area $S(1)$ per one side of said first

current collector sheet, an area $S(2)$ per one side of said second current collector sheet, and an area $S(s)$ per one side of said separator satisfy the following relations:

$$S(1) \leq S(s) \leq S(1) \times 1.05, \text{ and}$$

$$S(2) \leq S(s) \leq S(2) \times 1.05.$$

11. The electrochemical device in accordance with claim 1, wherein said electrochemical device further comprises a first terminal electrically connected to said first current collector sheet and a second terminal electrically connected to said second current collector sheet,

said electrode plate assembly has a first side face on which said first terminal is provided and a second side face on which said second terminal is provided,

when said first current collector sheet has a conductive area and an insulating area, the conductive area of said first current collector sheet is connected to said first terminal on said first side face, and the insulating area of said first current collector sheet is positioned on said second side face,

when said second current collector sheet has a conductive area and an insulating area, the conductive area of said second current collector sheet is connected to said second terminal on said second side face, and the insulating area of said second current collector sheet is positioned on said first side face, and

said first electrode mixture layer and said second electrode mixture layer each have an edge covered with an insulating material.

12. The electrochemical device in accordance with claim 11, wherein said edge of the first electrode mixture layer covered with the insulating material is positioned on said second side face, and said edge of the second electrode mixture layer covered with the insulating material is positioned on said first side face.

13. The electrochemical device in accordance with claim 11, wherein when said first current collector sheet has a conductive area and an insulating area, the insulating area of said first current collector sheet is adjacent to said edge of the first electrode mixture layer covered with said insulating material, and

when said second current collector sheet has a conductive area and an insulating area, the insulating area of said second current collector sheet is adjacent to said edge of the second electrode mixture layer covered with said insulating material.

14. The electrochemical device in accordance with claim 1, wherein said electrochemical device further comprises a first terminal electrically connected to said first current collector sheet, a second terminal electrically connected to said second current collector sheet, and a case accommodating said electrode plate

assembly,

said electrode plate assembly has a first side face on which said first terminal is provided and a second side face on which said second terminal is provided,

when said first current collector sheet has a conductive area and an insulating area, the conductive area of said first current collector sheet is connected to said first terminal on said first side face, and the insulating area of said first current collector sheet is positioned on said second side face,

when said second current collector sheet has a conductive area and an insulating area, the conductive area of said second current collector sheet is connected to said second terminal on said second side face, and the insulating area of said second current collector sheet is positioned on said first side face, and

an inner face of said case is in contact with said first side face and said second side face.

15. The electrochemical device in accordance with claim 14, wherein said case comprises a frame and two flat sheets,

said frame surrounds said electrode plate assembly and is in contact with said first side face and said second side face,

and said two flat sheets cover two openings of said frame and are in contact with an upper face and a

lower face of said electrode plate assembly.

16. The electrochemical device in accordance with claim 14, wherein said case comprises: a container with a bottom; and a flat sheet,

said container accommodates said electrode plate assembly and has side walls in contact with said first side face and said second side face and a bottom in contact with one of an upper face and a lower face of said electrode plate assembly, and

said flat sheet covers an opening of said container and is in contact with the other of the upper face and the lower face of said electrode plate assembly.

17. The electrochemical device in accordance with claim 14, wherein a lead piece is connected to at least one of said first terminal and said second terminal, and said lead piece is drawn out of said case.

18. The electrochemical device in accordance with claim 15, wherein a lead piece is connected to at least one of said first terminal and said second terminal, and said lead piece is drawn out of said case through a slit provided in said flame.

19. The electrochemical device in accordance with claim 16, wherein a lead piece is connected to at least one of said first terminal and said second terminal, and said lead piece is drawn out of said case through a slit provided in said side walls.

20. The electrochemical device in accordance with claim 2, wherein at least one of said first terminal and said second terminal comprises a porous metal film comprising metal particles joined continuously.

21. The electrochemical device in accordance with claim 2, wherein at least one of said first terminal and said second terminal comprises a conductive paste, said conductive paste comprises a resin and a conductive material dispersed in said resin, and said conductive material is in the form of fine particles and/or fiber.

22. The electrochemical device in accordance with claim 2, wherein at least one of said first terminal and said second terminal comprises a low melting-point metal having a melting point of 250°C or lower.

23. The electrochemical device in accordance with claim 7, wherein a metal lead is welded to said first terminal or said second terminal in which at least a part of said first edge is buried, and said first edge is in contact with said metal lead.

24. The electrochemical device in accordance with claim 2, wherein at least one of the current collector sheets of outermost two electrodes has a conductive area on both sides and has an electrode mixture layer only on one side facing the inner electrode, and the conductive area on the other side is electrically connected to said first terminal or said second terminal and serves as an extended

part of said terminal.

25. The electrochemical device in accordance with claim 9, wherein at least one of said third side face and fourth side face is covered with an electronically insulating porous material.

26. The electrochemical device in accordance with claim 25, wherein said porous material comprises at least one selected from the group consisting of polyolefin, polyalkylene oxide, fluoropolymer and ceramics.

27. The electrochemical device in accordance with claim 25, wherein said porous material comprises a film-shaped member or a coating film of paste.

28. The electrochemical device in accordance with claim 25, wherein the edge of said separator is joined to said porous material on the side face of the electrode plate assembly covered with said porous material.

29. The electrochemical device in accordance with claim 28, wherein said porous material and said separator comprise the same material.

30. The electrochemical device in accordance with claim 11, wherein said insulating material comprises at least one selected from the group consisting of a resin coating film and a resin tape.

31. The electrochemical device in accordance with claim 30, wherein said resin coating film is formed by applying a solution or dispersion containing an insulating

resin onto an edge of said electrode mixture layer and drying it.

32. The electrochemical device in accordance with claim 31, wherein said insulating resin comprises at least one selected from the group consisting of polyethylene oxide, polypropylene oxide, polyacrylonitrile, polyvinylidene fluoride, polymethyl methacrylate, and a copolymer, polymer alloy or polymer blend including at least one of these.

33. The electrochemical device in accordance with claim 30, wherein said resin coating film is formed by applying a solution or dispersion containing a polymerizable compound onto an edge of said electrode mixture layer and polymerizing said polymerizable compound.

34. The electrochemical device in accordance with claim 33, wherein said polymerizable compound has at least one functional group selected from the group consisting of an acrylate group and a methacrylate group.

35. The electrochemical device in accordance with claim 30, wherein said resin tape comprises an insulating base material and an insulating adhesive carried on said insulating base material.

36. The electrochemical device in accordance with claim 35, wherein said insulating base material comprises at least one selected from the group consisting of polyethylene, polypropylene, polyethylene terephthalate,

polyethylene naphthalate, polyphenylene sulfide, polyimide, aramid resin, and a copolymer, polymer alloy or polymer blend including at least one of these.

37. A method for producing an electrochemical device comprising the steps of:

(a) forming conductive layers on both sides of two insulating base material sheets, to obtain a first current collector sheet and a second current collector sheet,

(b) forming a plurality of first electrode mixture layers and a plurality of second electrode mixture layers on each of said conductive layers of said first current collector sheet and said second current collector sheet, respectively, in the form of parallel strips, with a gap therebetween, to obtain a group of first electrodes and a group of second electrodes,

(c) feeding said group of first electrodes and said group of second electrodes, with a separator therebetween, in the direction of length of said first electrode mixture layers and said second electrode mixture layers, and winding them concentrically, to obtain a wound body, and

(d) cutting said wound body at said gap, to obtain a plurality of wound-type electrode plate assemblies.

38. The method for producing an electrochemical device in accordance with claim 37, further comprising the

step of forming an insulating material portion on said conductive layer at said gap after said step (b) and before said step (c).

39. The method for producing an electrochemical device in accordance with claim 37, further comprising the step of coating a first bottom face and a second bottom face of said wound-type electrode plate assembly with metal, to form a first terminal and a second terminal.

40. A method for producing an electrochemical device, comprising the steps of:

layering a long group of first electrodes and a long group of second electrodes with a separator interposed therebetween and feeding the resultant layered body continuously;

winding said layered body on a bobbin that is shaped like a flat plate; and

cutting said layered body wound on said bobbin, to obtain a plurality of layered-type electrode plate assemblies.

41. The method for producing an electrochemical device in accordance with claim 40,

wherein said first electrodes and said second electrodes are obtained by the steps of:

forming conductive layers on both sides of two insulating base material sheets, based on a predetermined pattern, to form a first current collector sheet and a

second current collector sheet; and

forming first electrode mixture layers and second electrode mixture layers on each of said conductive layers of said first current collector sheet and said second current collector sheet, respectively, based on said pattern, with a gap therebetween.

42. The method for producing an electrochemical device in accordance with claim 41, wherein said predetermined pattern is shaped like a matrix.

43. The method for producing an electrochemical device in accordance with claim 41, wherein said predetermined pattern is shaped like parallel strips.

44. The method for producing an electrochemical device in accordance with claim 41, further comprising the step of forming an insulating material portion at said gap on said conductive layer at a position sandwiching each of said first electrode mixture layers and said second electrode mixture layers.

45. The method for producing an electrochemical device in accordance with claim 40, further comprising the step of coating opposite first and second side faces of said layered-type electrode plate assembly with metal, to form a first terminal and a second terminal.

46. A method for producing an electrochemical device, comprising the steps of:

(a) forming conductive layers on both sides of

two insulating base material sheets, based on a predetermined pattern, to obtain a first current collector sheet and a second current collector sheet;

(b) forming a plurality of first electrode mixture layers and a plurality of second electrode mixture layers on each of said conductive layers, based on said pattern, with a gap therebetween, to obtain a group of first electrodes and a group of second electrodes;

(c) layering said group of first electrodes and said group of second electrodes, with a separator therebetween, to obtain a layered body; and

(d) cutting said layered body at said gap, to obtain a plurality of layered-type electrode plate assemblies.

47. The method for producing an electrochemical device in accordance with claim 46, wherein said predetermined pattern is shaped like a matrix.

48. The method for producing an electrochemical device in accordance with claim 46, wherein said predetermined pattern is shaped like parallel strips.

49. The method for producing an electrochemical device in accordance with claim 46, further comprising the step of forming an insulating material portion at said gap on said conductive layer at a position sandwiching each of said first electrode mixture layers and said second electrode mixture layers, after said step (b) and before

said step (c).

50. The method for producing an electrochemical device in accordance with claim 46, further comprising the step of coating opposite first and second side faces of said layered-type electrode plate assembly with metal, to form a first terminal and a second terminal.